Terrestrial Habitats

Ectomycorrhizal Fungal Communities in Young, Managed, and Old-Growth Douglas-fir Stands

Thomas E. O'Dell, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331; Daniel L. Luoma, Department of Forest Science, Oregon State University, Corvallis, OR 97331; and Randolph J. Molina, Pacific Northwest Experiment Station, U.S. Department of Agriculture Forest Service, 3200 Jefferson Way, Corvallis, OR 97331

Mycorrhizae ("fungus roots") are the mutually beneficial associations of plant roots with fungi. Thousands of fungal species, principally ones producing mushroom and truffle-like sporocarps (spore-producing fruit), form mycorrhizae with forest trees in the Pacific Northwest. The fungi extend tree root systems, providing water, nutrients, and other benefits. In return, the tree supplies mycorrhizal fungi with carbohydrates (Harley and Smith 1982; Allen 1991). The community structure and sporocarp production of ectomycorrhizal fungi are under study in stands of Douglas-fir (*Pseudotsuga menziesii*) in and near the H. J. Andrews Experimental Forest, in Oregon's Western Cascade Range.

To better understand the impacts of forest management on these organisms, we sampled sporocarps (mushrooms and truffles) of ectomycorrhizal fungi from nine Douglas-fir stands. Three age classes of Douglas-fir were chosen, representing young with closed canopy (YCC, 25-30 years old), rotation age (ready for harvest RA, 50-60 years old), and old growth (OG, 400+ years old). The two younger age classes are plantations; the old growth was naturally established. Three stands of each age class with similar understory vegetation, indicating mesic conditions (requiring moderate amounts of water) were selected. Sampling occurred in Fall 1991. Mushrooms were collected from a total area of 700 m² per stand; truffles were collected from a total area of 100 m² per stand. These sporocarps were identified, dried and weighed. Voucher collections of all taxa from each stand are in the Oregon State University Herbarium.

The data are preliminary, being the first result of a long-term study. Results are summarized in Table 1. Twenty-five species of ectomycorrhizal fungi, 15 mushroom taxa, and 10 truffle taxa, were harvested from a total area of 6,300 m² (9 stands•700 m²/stand).

The number of mushroom species (richness) was highest in OG stands (12 species), followed by RA stands (seven species), and YCC stands (one species). *Cantharellus cibarius* occurred in all age classes. *Cortinarius traganus* and *Ramaria* sp. occurred in both the RA and OG age classes. Other mushroom species were restricted to stands of a single age class; eight of the fifteen occurred in a single stand. In contrast, truffle species richness showed little variation with five to seven species per age class, and most species occurred in all ages, a result similar to that of Luoma and others (1991). Four species—*Cantharellus cibarius, Russula fragrantissima, Russula albonigra*, and *Russula brevipes*—accounted for over 85% of mushroom biomass, with *Cantharellus cibarius* alone contributing almost 50% of the total.

TABLE 1. Numbers of species (richness) and sporocarp production of ectomycorrhizal fungi in Douglas-fir stands of three age classes; values obtained from 2,100 m² sampling area (3 stands•700 m² per stand) in each age class. Sampling was done on and near the H. J. Andrews Experimental Forest, Willamette National Forest, Oregon in Fall 1991.

Age class:	(n = 3) Young with closed canopy	(n = 3) Rotation age (ready to harvest)	(n = 3) Old growth
Total mushroom species[1]	1	7	12
Total truffle species[1]	5	7	7
Total species[1]	6	14	18
Average richness (species/stand)[1]	1	2.3	6.0
Average mushroom biomass (kg/ha)	0.5	0.1	0.7
Average truffle biomass (kg/ha)	1.3	0.9	0.3
Average sporocarp biomass (kg/ha)	1.8	1.0	1.0

[1] Species richness is based on occurrences in systematically sampled plots; species occurring outside of plots are not included in this table.

These results suggest that habitat modification (e.g., continued logging of old-growth and rotation-age forests), may affect fruiting of some mushroom species. In Europe, concern is growing over declining mushroom production (Arnolds 1991). Such declines could be occurring in North America, but we lack any long-term data from which to draw conclusions (Cherfas 1991). Because ectomycorrhizal fungi are important to forest health, it is urgent that we devote more resources to their long-term study.

The assistance of Doni McKay, Michael Morneau, Jane Smith, and the H. J. Andrews Experimental Forest, Blue River Ranger District, Willamette National Forest is gratefully acknowledged.

References

Allen, M. F. 1991. *Ecology of mycorrhizae*. Cambridge, UK: Cambridge University Press.

Arnolds, E. 1991. Decline of ectomycorrhizal fungi in Europe. *Agric. Ecosys. Env.* 35:209-244.

Cherfas, J. 1991. Disappearing mushrooms: another mass extinction? *Science* 254: 1458.

Harley, J. L., and S. E. Smith. 1982. *Mycorrhizal symbiosis*. London: Academic Press.

Luoma, D. L., R. E. Frenkel, and J. M. Trappe. 1991. Fruiting of hypogeous sporocarps in Oregon Douglas-fir forests: Seasonal and habitat variation. *Mycologia* 83:335–353.

Fungi of Old-growth Forests in British Columbia

Sharmin Gamiet and Shannon M. Berch, Department of Soil Science, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z4

In British Columbia (B.C.), old-growth forests are found in each of the 14 different biogeoclimatic zones. For each zone, the diversity of conifer, vegetation, and soils has been determined. However, there is no information on the diversity of the fungi for each of these zones.

Although biodiversity studies have occurred in some parts of the United States of America, in both old-growth and mature stands, little work has been done in B.C. The objective of this study is to determine the diversity of the larger fungi in old-growth forests in the Coastal Western Hemlock (CWH) biogeoclimatic zone of B.C.

TABLE 1. Fungi found at University of British Columbia Research Forest: Fall 1991–Spring 1992.

Ascomycetes

Hypocreaceae
Hypomyces luteovirens (Fr.)Tul.

Leotiaceae
Bisporella citrina (Batsch ex Fr.)Korf & Carp
Cudonia circinans Fr.

Sarcosomataceae
Pseudoplectania melaena (Fr.)[illegible]

Stictidaceae
Vibrissea truncorum Alb. & Schw. ex Fr.

Xylariaceae
Xylaria hypoxylon (L. ex Hook.)Grev

TABLE 2. Fungi found at University of British Columbia Research Forest: Fall 1991–Spring 1992.

Basidiomycetes

Amanitaceae
Amanita porphyria (Alb.& Schw. ex Fr.)Secr.

Bolbitiaceae
Conocybe sp.

Cantharellaceae
Cantharellus cibarius Fr.

Clavariaceae
Clavulina cinerea (Fr.)Schroet.
C. cristata (Fr.)Schroet.
Ramaria stricta (Fr.)Quel

Cortinariaceae
Alnicola melinoides (Fr.)Kuhn
Galerina spp.
Gymnopilus sp.
G. bellulus (Peck) Murr.
Inocybe sp.
I. calamistrata (Fr.)Gill.
I. fuscodisca (Peck)Mass
I. geophylla (Sow. ex Fr.)Kummer
I. radiata Peck
Naucoria sp

Crepidotaceae
Crepidotus spp.
Crepidotus occidentalis Hess. & A.H.Smith

Dacrymycetaceae
Calocera viscosa (Pers. ex Fr.)Fr.
Dacrymyces palmatus (Schw.)Bres.
Heterotextus luteus (Bresadola) McNabb

Entolomataceae
Entoloma sp.

Ganodermataceae
Ganoderma applanatum (Pers.)Pat.

Gomphidiaceae
Chroogomphus tomentosus (Murr.)Mill.

Hydnaceae
Dentinum umbilicatum (Peck)Pouzer

Hygrophoraceae
Hygrocybe laeta (Pers. ex Fr.)Kummer
Hygrophorus eburneus (Bull. ex Fr.)Fr.

Lycoperdaceae
Lycoperdon foetidum Bonor.
L. perlatum Pers.

Nidulariaceae
Nidula candida (Peck)White

Paxillaceae
Paxillus involutus (Batsch ex Fr.)Fr.

Pluteaceae
Pluteus cervinus (Schaeff. ex Fr.)Kummer

Polyporaceae
Trichaptum abietinum (Dicks ex Fr.)Ryv.

Russulaceae
Lactarius luculentus Burl.
Russula sp.
R. alutacea (Pers. ex Schwein.)Fr.
R. brevipes Peck
R. cyanoxantha (Schaeff. ex Schwein.)Fr.
R. nigricans (Bull.) Fr.
R. vesca Fr.

Strophariaceae
Hypholoma capnoides (Fr.)ex Fr. Kummer
Pholiota astragalina (Fr.) Sing.
P. flammans (Fr.)Kummer
P. scamba (Fr.)Mos.

Tremellaceae
Tremella encephala Pers.

Tricholomataceae
Armillaria mellea (Vahl ex Fr.)Karst
Collybia confluens (Pers. ex Fr.)Kummer
C. oregonensis (A.H.Smith)
Hemimycena delectabilis (Peck)Sing.
Marasmiellus pluvius Redhead
Marasmius androsaceus (L. ex Fr.)Fr.
Micromphale perforans (Hofm.& Fr.)Sing.
Mycena spp.
M. alnicola A.H.Smith
M. amabilissima (Peck)Sacc.
M. amicta (Fr.) Quel.
M. aurantiomarginata (Fr.) Quel.
M. elegantula Peck
M. epipterygia (Scop. ex Fr.) S.F. Gray
M. fagetorum (Fr.)Gill.
M. griseiconica Kauffm.
M. haematopus Pers.
M. laevigata (Lasch)Quel
M. leptocephala (Pers. ex Fr.) Gill.
M. longiseta Hohnel.
M. paucilamellata A.H.Smith
M. pterigena (Fr.)Kummer
M. pura (Pers. ex Fr.)Kummer
M. rorida (Scop. ex Fr.)Quel.
M. rugulosiceps (Kauff.)A.H.Smith
M. subsanguinolenta A.H.Smith
Phytoconis ericetorum (Pers.ex Fr.)Redhead & Kuyp.
Pleurocybella porrigens (Pers. ex Fr.)Sing.
Pseudoarmillariella ectypoides (Sing.)Sing.
Rickenella fibula (Bull. ex Fr.)Raith
Strobilurus albipilatus (Peck) Wells & Kempton
S. trullisatus (Murr.)Lennox
Xeromphalina fulvipes (Murr.)A.H.Smith